Helping First-Year Engineering Students Select a Major

Dr. Tammy VanDeGrift, University of Portland

Dr. Tammy VanDeGrift is an Associate Professor of Computer Science at the University of Portland. Her research interests include computer science education, pedagogy, and best practices for retention and engagement.

Miss Sherry Liao, University of Portland

A rising software engineer inspired by the ability of technology to connect the world together and make a positive impact on a global level.

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Abstract

This evidence-based practice paper evaluates a set of resources to help first-year engineering students choose their major among four fields. Choosing a major can be a daunting task for first-year college students, especially if the choices span fields with which students have little experience. In order to provide first-year engineering students time to discern, a set of resources and course activities were designed to assist students in this decision-making process. The educational theory that serves as a framework for this study is social cognitive career theory, developed by Lent, Brown, and Hackett in 1994. In particular, resources, activities, and experiences in the introduction to engineering course were designed to assist students with self-efficacy beliefs and personal goals.

At this University all engineering and computer science students take an introduction to engineering course that covers the engineering process, teamwork, communication skills, the different branches of engineering, ethics, and co-curricular and extracurricular opportunities. Section sizes are ~30 students, so students can build community with peers and their professor. The professor of the Introduction to Engineering course is the academic advisor for his/her set of students. Students declare or confirm their major by the end of the first semester. Resources to help students choose a major include laboratories, advisor meetings, student panels, a semester-long team project, student chapters of professional society meetings, and on-line resources.

In the fall 2012 offering of the course, we collected paper surveys from students, asking them to rate the effectiveness of a suite of resources in helping them choose their major. We asked about exposure to engineering and/or computer science prior to entering college and course materials and activities that were helpful for selecting a major. Based on the responses, we created a new set of videos and blogs featuring upper-class students who shared their journeys in how they chose their major and what they value about their major. We added new labs for the 2015 version. In fall 2015, we again asked students about the impact of all the course activities and their confidence in their major selection.

The professor as advisor, laboratories and the course project have the most impact on helping students decide their major. More informational activities such as talking to other students, attending club meetings, and watching videos of other students had less impact. Based on these results, students seem to need personal, hands-on experience to determine if their self-efficacy beliefs and the values of the outcomes align with the intended major. 145 of 154 (94.2%) of students were somewhat or very confident about their major at the end of the semester.

This paper describes a suite of resources and activities along with students' evaluation of those materials in terms of discernment of their major. By disseminating the information, other universities can adopt and adapt these activities to use in their programs.

1. Introduction

Choosing a major is a daunting task for many first-year college students, especially if the choices span fields with which students have little exposure and experience. It is estimated that 20 – 50% of first-year college students enter college as "undecided" about their major[7]. In order to provide first-year engineering students time to discern, a set of resources and course activities were created and assessed in an introduction to engineering course. The results of two studies are presented in this paper.

The structure of the remainder of the paper is as follows. The next section describes the educational theory relevant to this study, models of introduction to engineering courses, and the context of the institution where the study took place. We then describe the studies, participants, and results from surveys administered in two different semesters. Following the results, we discuss the answers to the research questions and relevant theory.

2. Background

Theory

The educational theory that serves as the primary framework for this project is social cognitive career theory, developed by Lent, Brown, and Hackett in 1994[9,11,12,16]. SCCT is based on three constructs: self-efficacy (a person's confidence that they can perform a task), outcome expectations (consequences that people anticipate resulting from actions), and a person's goals. These three constructs play an important role in a person's interests and career choice. Contextual and environmental factors, such as a person's gender, ethnicity, and age are considered barriers or support and can influence the constructs of self-efficacy, outcome expectations, interest, and goals.

SCCT has been applied to study people in a variety of fields, including engineering. Inda and colleagues tested SCCT for engineering students in Spain[9]. They found that the SCCT model explained the data they collected. They looked further to examine differences between men and women and found that there were no differences with respect to outcome expectations and goals between these two groups. There was a difference in self-efficacy and interest (less for women than men).

Cardella and colleagues used SCCT to analyze behavior of middle-school children as they interacted with the Design Squad website[2]. They interviewed and surveyed children, parents, and educators and coded the data collected. They wanted to better understand how the four tenets of SCCT are developed among children in informal learning environments.

Lent and others studied SCCT among first-year engineering students to explain their major choices[11,12]. Self-efficacy and outcome expectations were good predictors of students' interests. They also studied collective efficacy beliefs (a new construct where group participants' beliefs about performance to work together as a unit rather than individuals). Not surprisingly, collective efficacy beliefs were related to team cohesion and team satisfaction levels.

Major Selection

While SCCT has been tested in various contexts, this paper focuses more on what resources students find valuable in order to select their major within engineering (or to choose a major outside engineering). Others have investigated what factors influence students' choices of major[6,13,26]. For example, Ortega-Alvarez and others examined engineering students' values[19].They coded interview transcripts and survey responses into codes for value, competence, and expectation (categories for expectancy-value theory). Most reasons fell into one of these categories, but they found that family and being well informed about career choice were additional reasons not explained by the theory.

Through qualitative interviews with students, Matusovich and colleagues studied engineering students' comments using expectancy-value theory, which includes competence beliefs (can I do this?) and task value beliefs (do I want this?)[15]. They found that women had lower attainment values (being an engineer is consistent with sense of self) than men. Also, those that persist in the field have higher attainment values than those who do not. Their recommendations include providing many views of the field of engineering, so that students can connect their sense of self to the engineering profession.

Carnasciali and colleagues studied factors that influenced students' major decisions[3]. They surveyed 97 students from 8 programs and found that gender and parental education level were factors in major choice. Only 66% of students indicated they had determined their specific major before visiting universities, which is consistent with Gordon that 20 – 50% of students arrive to college undecided about their major.

Watson and others surveyed first-year civil engineering students about their reasons for pursuing engineering[28]. After the reasons were coded into categories, the top five categories were behavioral factors (wanting to fix, build, and solve), that the field is challenging, psychological factors (interest in the field), financial factors (job opportunities and job security), and social good (benefiting society). They further investigated differences in factors between those that stayed in engineering and those that left. They did not find any statistical differences between those that stayed and those that left. They recommend that first-year course activities should cover a broad spectrum of these student motivations.

Introductory Engineering Course Models

Several different curricular models are used in Introduction to Engineering courses. Some universities have students take two or more discipline-specific modules to learn about two or more different branches of engineering[27,29]. Other universities have a unified Introduction to Engineering course to introduce all students to the different engineering programs[18]. A third approach is to have students take a discipline-specific introductory course, such as an introduction to problem solving in bioengineering[22]. The first and second approaches provide students information and experiences prior to selecting a major, whereas the third approach assumes students have selected their major before the first year at the university.

The course materials within an introduction to engineering course vary from institution to institution. Some courses utilize a semester-long design project to expose students to engineering design skills[5,20]. These projects may be discipline-specific[25], involve multiple disciplines[31], involve clients[8], and even focus on the engineering student process[4,23]. Some courses use a series of smaller labs and mini projects to provide more variety and the option to re-form teams across the semester. Many courses integrate presentations and guest speakers about the branches of engineering. Some courses have the professor serve as the faculty/academic advisor for the students[14]. Each course has been developed with the university's context in mind, so a specific Introduction to Engineering course model may not easily transfer to another institution. The curriculum model that is explored in this paper uses a team-based semester-long design project combined with a few supplementary labs where the professor serves as the students' faculty advisor.

3. Context, Studies and Participants

Context

The project took place at a private university serving ~3800 undergraduate students on the west coast of the USA. Of the 3800 students, about 700 major in engineering or computer science across all cohorts. The student population is mostly traditional, with most students entering the University directly after high school. Furthermore, all University majors are designed to fit into a four-year, eight-semester schedule, so students expect to graduate with a degree after four years of study. Students are directly admitted to the School of Engineering at the University; there is no secondary admissions process to start a specific program of study. As long as students remain in good standing academically, students may select any major within the School of Engineering and may choose to switch majors at any time.

All engineering and computer science students take Introduction to Engineering (referred to as EGR 100 in this paper) during the fall semester of their first year. The 2-credit semester course exposes students to engineering design, the design process, communication skills, teamwork, extra and co-curricular opportunities for engineering students, ethics, and the engineering and computer science disciplines. One goal of the course is for students to have a better understanding of the disciplines, so they can make an informed choice about their major. The University offers four ABET-accredited programs: Civil Engineering, Electrical Engineering, Mechanical Engineering, and Computer Science. Although students can declare one of the four majors prior to entering the University, the professors of EGR 100 emphasize that students should consider all four programs during the fall semester. The curriculum is designed so that all first-year students take the same set of courses (usually Physics, Calculus, EGR 100, and two humanities courses) their first semester to keep them on track for all four programs. The three engineering majors have a common set of spring semester courses while the computer science program has a programming course and lab in Java instead of Matlab and chemistry courses during spring semester. Students confirm or change their major at the end of the fall semester as part of the EGR 100 course. The specific resources aimed to help students choose their major are described in more detail in the sections below.

Section sizes of EGR 100 are ~30 students to help students build community with their peers and their professor. Along with teaching the course, the professor is assigned as the faculty advisor for the students enrolled in his or her section. During weeks 9 – 11 of the semester, the professor meets individually with every student to discuss their interests, goals, and transition to college prior to registration for spring courses.

Research Questions

The main purpose of these studies is to better understand what resources (mandatory and optional) in the EGR 100 course help students determine their major. The research questions include: R1) Which activities do students find most helpful to choose their major?, R2) Are students confident about their choice?, and R3) After the course, do students have an understanding of the branches of engineering and what engineers do?

Surveys

Two studies were conducted in the EGR 100 course to assess course elements and their impact on helping students choose a major: a survey study in fall 2012 and another survey study in fall 2015. We collected paper surveys from students, who completed them voluntarily and anonymously at the end of the semester. The surveys asked students to answer yes/no and Likert-scale-like questions about course materials to gauge how effective the course materials were in helping them to select a major. In the fall 2012 survey, we asked about their prior exposure to engineering and computer science. 84 of 172 (48.8%) of first-year students said they had prior exposure to engineering, so at least half of the students were really starting their program with little or no knowledge about the field. Based on their responses, we created a new set of videos and student blogs showcasing upper-class students, their journeys, and how they decided on their major. We created three new labs, so students experienced a lab connected to each discipline.

Participants

In fall 2012, 172 of 198 (86.8%) enrolled students completed the survey. Of the respondents in fall 2012, the program distribution was: 36 civil engineering, 39 computer science, 28 electrical engineering, 50 mechanical engineering, 7 undecided engineering, 5 undecided (general), and 18 chose a non-engineering major. The total exceeds the number of participants, since some students checked multiple boxes in the survey.

In fall 2015, 154 of 218 (70.6%) enrolled students completed the survey. In fall 2015, one section of the course gave the surveys to students to complete outside of class time, which impacted the response rate. Of these respondents, the program distribution was: 23 civil engineering, 34 computer science, 14 electrical engineering, 72 mechanical engineering, 1 double major in EE/CS, 2 undecided engineering, 1 undecided (general), and 7 chose a non-engineering major.

4. Course Elements and Results from 2012

Table 1 describes the course activities related to helping students choose a major that were assessed in fall 2012. We asked students to check boxes (all that apply) for activities that helped them select their major.

Table 1: Course Activities Assessed in Fall 2012; required course activities are marked with *

Activity	**Description**
Course Project (CP)*	Students worked in 3- or 4-person teams to design, build, and test a Lego Mindstorms[10] robot that navigated a room, avoided mousetraps, and activated lights; At the end of the semester, students participated in a public competition. Two lectures were designated as labs to assist students in learning how to program the robot. As part of the design project, students wrote design reports and gave an oral presentation at the end of the semester.
Truss Project (TP)*	Students worked on 3-4 person teams to design and build a truss from balsa wood and wood glue. Teams tested the total force the truss could withstand. This mini project was linked to the Civil Engineering discipline.
Program Presentations (PP)*	Every program had faculty give guest presentations about the field to every EGR 110 section; the professor of the section gave the presentation for his/her field to his/her section.
Alumni Videos (AV)*	The CE, EE, and CS programs created videos about alumni speaking about their jobs; these were shown in class as part of the program presentations and available on the course website.
Club Meetings (CM)*	Students were required to attend one student organization meeting related to engineering or CS, such as: ACM, IEEE, EWB, SWE, ASME, ASCE, EWH, ASHRAE, ASM, SAE, Robotics Club. These meetings provide a space for first-year students to meet sophomores through seniors. Club meeting activities include guest speakers from industry, design projects, and service projects.
Resources on EGR 100 website (WR)	Web resources from ASEE, professional societies, and professional magazines were posted to the course website.
Student Research (SR)	Student's own research about the disciplines
Talking to People (PP)	Conversations with sophomores – seniors, engineers, EGR 100 professor, other engineering faculty, parents, family/friends. Note that a 1-1 meeting with the professor was required as part of academic advising.
Meeting with Academic Advisor/Counselor (AA)	An academic counselor (staff member) for the School of Engineering is available for students; she helps students track degree progress and answers questions about university regulations. No meeting was required, but she was available through office hours.
Meeting with Staff at Career Center (CC)	A University-wide career center is available for students for drop-in and appointments.
Meeting with Staff at Resource Center (RC)	A University-wide academic resource center is available for students to get additional help with academic success strategies such as time management, tutoring, and test-taking.

Figure 1 shows the number of students who indicated that the resource was helpful for selecting a major. Students felt that the program presentations and their own personal research contributed the most to helping them choose their major. University staff, such as the staff academic advisor and those at the career center and resource center had little impact on the students; do note that meeting with these staff members was NOT a required part of EGR 100, but students were made aware of these resources as options.

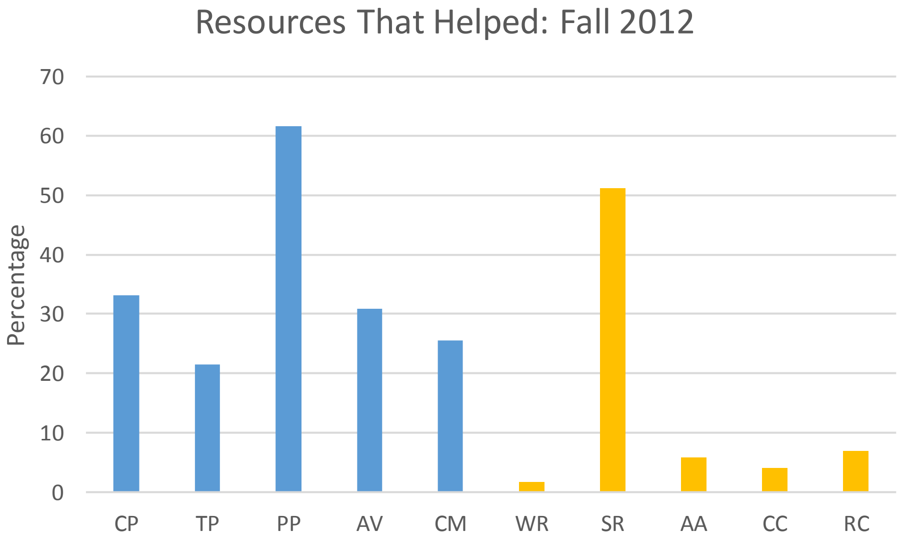

Figure 1: Percentage of students who indicated that the course element was helpful for deciding major (N = 172); CP through CM were required (blue). WF through RC were optional (orange).

Figure 2 shows the number who felt it was helpful talking to different groups of people. 28 of 172 (16.3%) did not check the box for any of the groups of people listed in Figure 2. About half of the students utilized their family and friends to help them make a decision. Just over a third sought the advice of practicing engineers. About a third sought advice from sophomore to senior engineering and computer science students. Because we cannot replicate family and friends as resources for students, we can help all first-year students by connecting them with older students and practicing engineers through videos and club meetings. We created new videos showcasing upperclass students describing their major, their courses, and their projects. We asked upperclass students to blog during summer internships, research experiences, and study abroad programs. Student bloggers received a stipend for their writing. These resources can be found from links at https://sites.up.edu/engineering/.

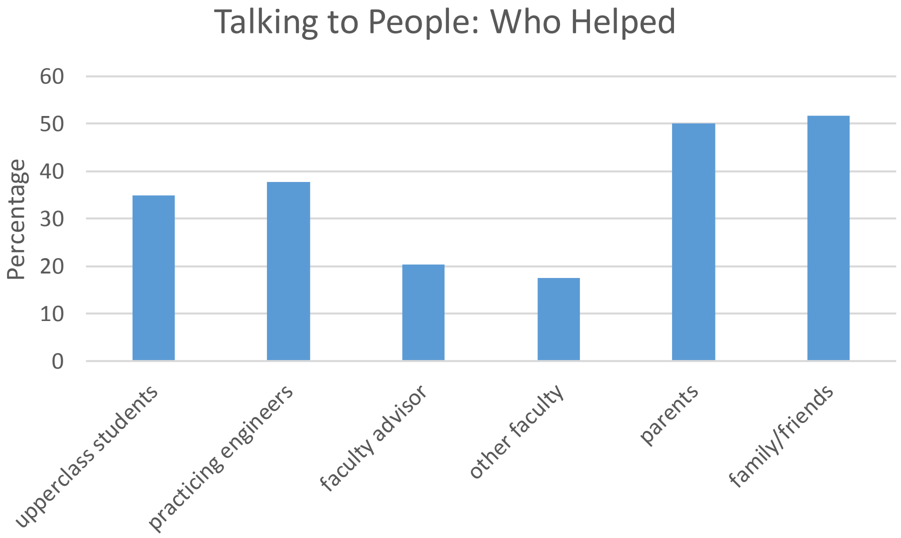

Figure 2: Percentage of students who indicated that talking to these people was helpful to decide major (N = 172)

Finally, the survey asked questions related to how students view engineering, engineering skills, and their degree. For the statements, students could choose from the following answers: strongly disagree (SD), disagree (D), neutral (N), agree (A), strongly agree (SA), and not sure (NS). The statements were:

- I have more interest in pursuing an engineering/CS degree now than I had at the beginning of the semester.
- I can see myself working in the engineering or computer science profession.
- I understand the types of jobs engineers and computer scientists do.
- I am confident that I will succeed in completing my degree in engineering/CS.
- Engineering and computer science projects utilize innovation and creativity.
- Engineering and computer science projects utilize teamwork.
- Engineering and computer science projects utilize mathematics and science.

Figures 3 and 4 show the distributions of student agreement with or disagreement with these statements. Overall, students generally agreed with the statements about their role in the profession. Almost all students agreed that engineering and computer science projects utilize all three aspects: innovation, teamwork, math/science.

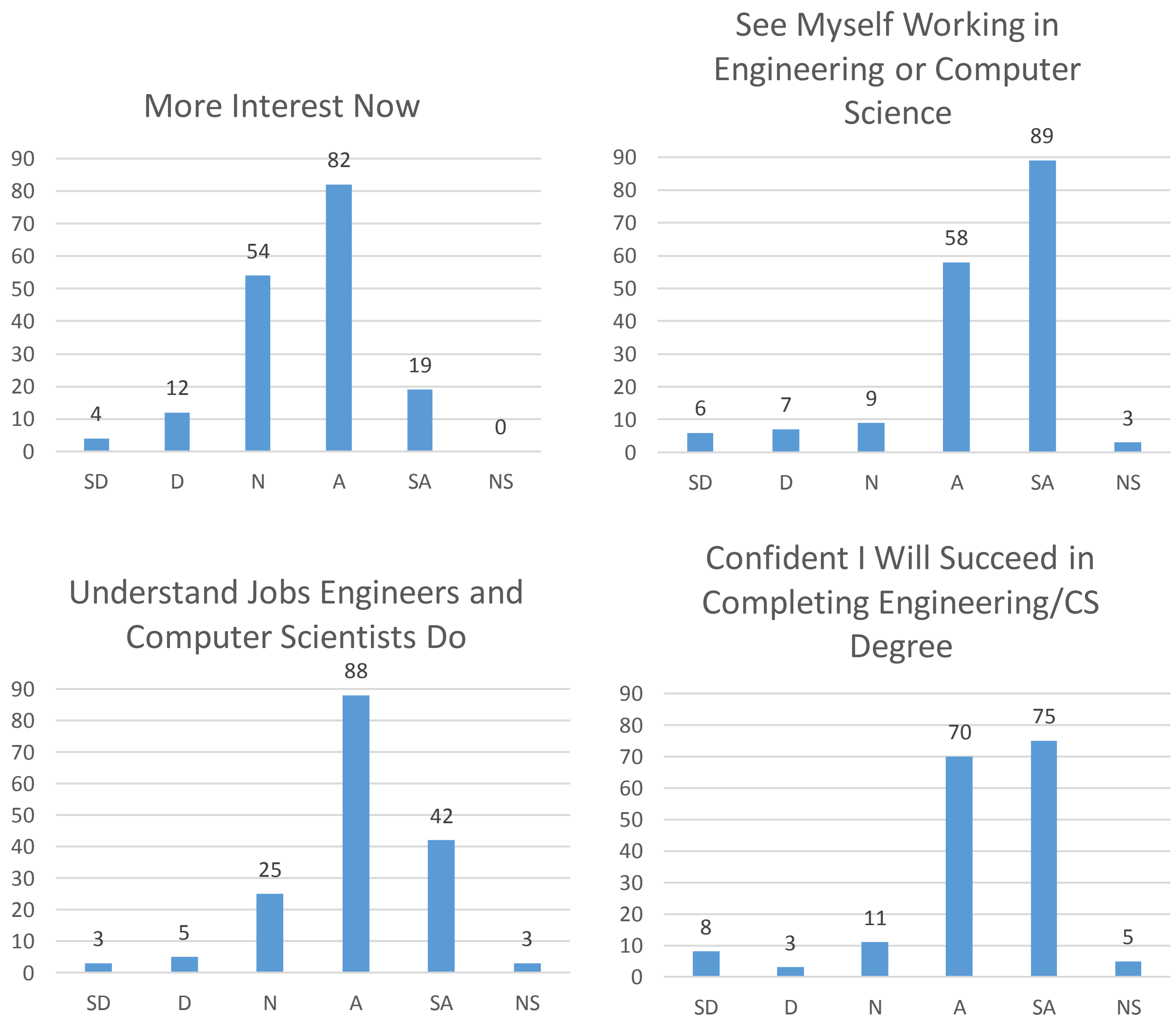

Figure 3: Distribution of students who indicated disagreement to agreement with the statements (N = 172); SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree, NS = Not Sure

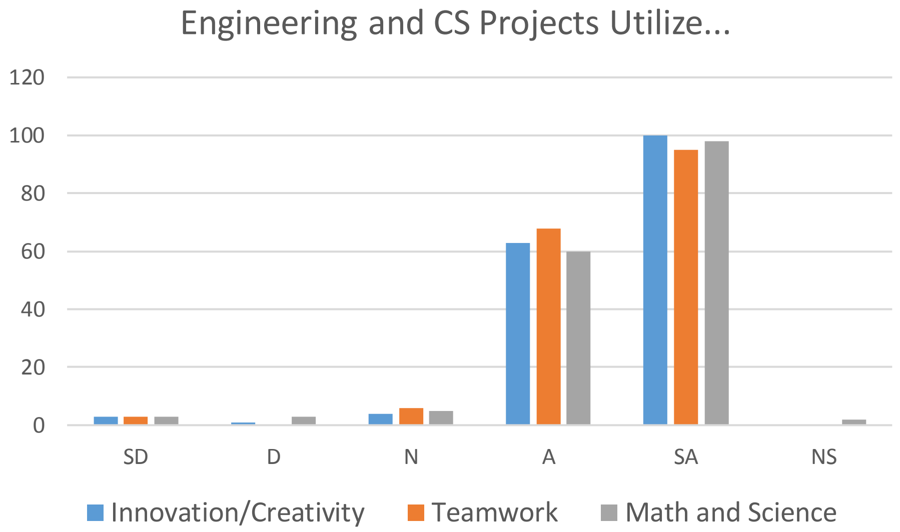

Figure 4: Distribution of students who indicated disagreement to agreement with the statements about engineering/CS projects (N = 172); SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree, NS = Not Sure

5. Course Elements and Results from 2015

Based on the results from 2012, new course elements were added to EGR 100 to help students choose a major. Table 2 describes the new activities.

Table 2: New Course Activities Assessed in Fall 2015; required course activities are marked with *

Activity	Description
CS Lab (CS)*	A one-lecture lab featuring AppInventor[17] was added to the course since the semester-long project no longer featured Lego Mindstorms[10]. AppInventor is a visual programming language to develop apps on the Android platform.
EE Lab (EE)*	A one-lecture lab featuring Arduino[1], wiring circuits, and using sensors/speakers was added to the course to expose students to electrical engineering.
ME Lab (ME)*	A one-lecture lab featuring Solidworks[24] 3D modeling and printing was added to the course to expose students to an aspect of mechanical engineering.
Student Research Assignment (SR)*	Students wrote a research paper about an existing engineering project and researched how different engineers contributed to the project.
Student Panel (SP)*	Sophomore, junior, and senior engineering and CS students volunteered as panelists during a lecture; first-year students had the opportunity to ask questions and learn from other students' experiences. Panelists were selected such that each major was represented.

Resources on EGR 100 website (WR)	New videos featuring upper-class students (how they chose their major, internship experience, capstone projects) were created by an undergraduate student and added to the set of web resources; Student blogs about their summer internships and study abroad programs were also added to the set of web resources. Presentations about the disciplines were available on the EGR 100 website.

In order to create lecture time for the new labs, the presentations about the professions were not given during lecture time. Instead, those presentations were posted to the course website and students were encouraged to view these resources when preparing their student research assignment.

The semester project featured 3- or 4- person teams, but it no longer used Lego Mindstorms. Instead, students were given seven potential engineering challenges to complete. All challenges were related to assistive devices and assistive technology to showcase engineering for social good: designing a way for wheelchairs and occupants to enter a residence hall, a device to remind the user when to take their medication, a device to move a can or pantry object for someone without grip strength, a solution for pooled water that accumulates in front of the main entrance to an academic building, a device to detect temperature of liquids (such as running water) for someone who is blind, a safe distance detector for someone who cares for a child or adult that needs supervision, a phone holder to aid someone with Parkinson’s disease. The labs gave students experience with programming smart phone apps, using an Arduino, and 3D printer; students were encouraged to use these skills when designing and creating their devices for the semester-long project. Students had freedom to complete their design prototypes from different types of materials and to identify the scope of their project within the design challenge.

The balsa truss project (TP) related to civil engineering, club meeting attendance (CM), meeting with the professor for advising (AD), and optional staff resources (academic advisor, career services, resource center) continued in 2015 (see section detailing results from 2012).

In the survey, students were asked to rate course elements as being very helpful, somewhat helpful, not helpful, or N/A. Note that there are four potential responses as opposed to the yes/no responses we collected in 2012 in order to get more detailed information about what helps and what students find very helpful. To have a comparison with the 2012 results, we show the responses for (Very + Some) for the course activities designed to help students choose a major. Figure 5 shows the distribution of responses.

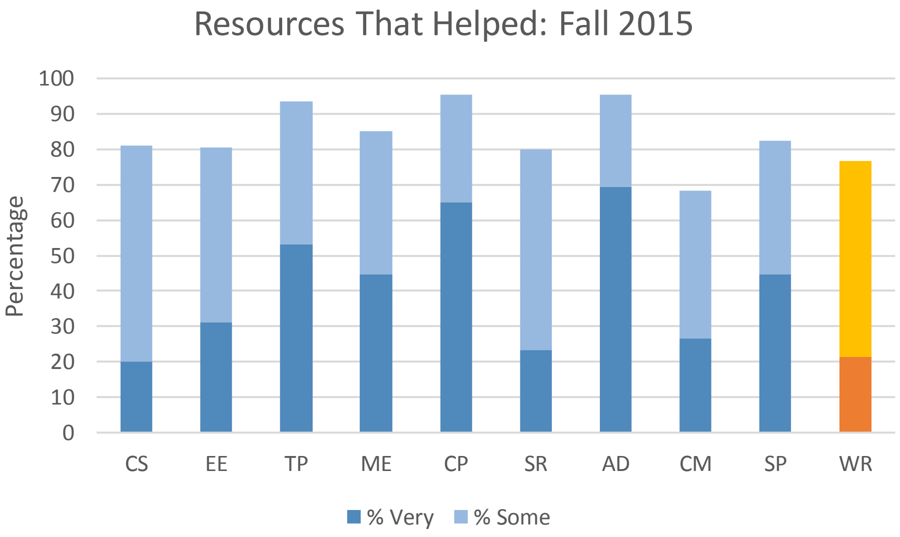

Figure 5: Percentage of students who indicated that the course element was helpful for deciding major (N = 154); CS to SP were required (blue); WR was optional (orange).

Overall, most students found the activities in Figure 5 helpful for choosing their major. The course project was rated as helpful by 33% of students in Fall 2012 and rated as helpful by 95% of respondents in Fall 2015. This change may result from the move from a single robotics project challenge (all teams built robots for the same task) to the set of seven challenges where students could choose their project and had more freedom in designing the prototype. Students may have felt the open-ended structure of the 2015 project provided more room for research and innovation.

Another major change was that 20% of students found their EGR 100 professor to be helpful in choosing a major in 2012 and 95% found their EGR 100 professor to be helpful in choosing a major in 2015. The faculty changed somewhat between 2012 and 2015; four faculty taught both offerings of the course. In fall 2012, one of six faculty were female. In fall 2015, three of seven faculty were female. In both course offerings, the faculty served as academic advisors to the students in the section. The structure changed somewhat in 2015 – the individual advising appointments took place during the hour the class usually met, so the students may have seen advising to be more integrated into the course. While students met with faculty for advising, the other students had project work time in the lab during three weeks of class sessions prior to course registration. In 2012 the advising appointments were scheduled by the faculty member and some occurred during class time and some occurred outside class time.

The truss project also had more impact in 2015 than in 2012, despite the project not being changed between the two course offerings. The web resources were also more helpful (note that this contained student videos, student blogs, websites, and the professions presentations and the professions presentations were deemed helpful in 2012). The new elements: CS lab, EE lab, ME lab, student research assignment, and student panel were helpful for students in choosing their major.

We also assessed students with Likert-scale-like questions (strongly disagree, disagree, neutral, agree, strongly agree, N/A) to the following statements:

- I am confident in my choice of major.
- The EGR 100 course has improved my understanding of the different branches of engineering and computer science.
- The EGR 100 course improved my understanding of the advising and registration process. *(This question was asked to evaluate the advising process and is not as relevant to this study.)*

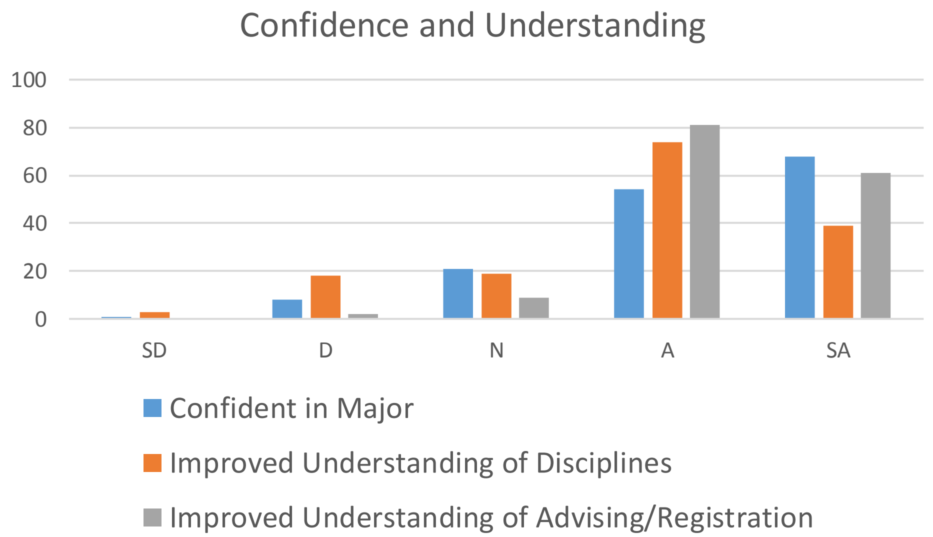

Figure 6: Number of students who agreed with and disagreed with statements (N = 154); SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

Almost all students were neutral to strongly agree with the three statements. 21 of 154 (13.6%) students did not feel they had an improved understanding of the different branches of engineering and computer science. It is interesting to look at the confidence levels of these 21 students to see if improved understanding of the disciplines is associated with confidence levels. Of the 21, 13 were confident in their major and their suggestions indicate that they already knew about the disciplines. One student suggested offering a more accelerated version of the course and one suggested using ‘actual coding’ instead of AppInventor. Of the 21, 4 were neutral in their confidence in the major. Of the 21, 4 disagreed or strongly disagreed with confidence in their major. For this subset of 21, there is no strong association between improved understanding and confidence. Looking at the subset of those who are not confident (9 students reported disagree or strongly disagree to confident with major choice), 5 agreed or strongly agreed that they had an improved understanding of the disciplines and 4 disagreed or strongly disagreed that they had an improved understanding. Thus, confidence and understanding are not completely associated with each other.

We asked students to rate their confidence level regarding their choice of major before starting at the University and at the end of the first semester. Students chose one of three ratings: not confident at all, somewhat confident, very confident. We measured the change of confidence and coded students as having increased confidence, decreased confidence, or the same.

Table 3 shows the results of the before and after the course with respect to confidence. Over the semester, students generally shifted to being more confident about their major choice.

Table 3: Confidence levels in major choice before and after EGR 100

	Before EGR 100	*After EGR 100*
Not confident	18	9
Somewhat confident	71	57
Very confident	65	88

Of the respondents, 46 *increased* in confidence, 14 *decreased* in confidence, and 94 *stayed the same*. Of the 14 who decreased in confidence, 9 went from very to somewhat confident, 2 went from very to not confident, and 3 went from somewhat confidence to not confident. Of these 14, the majors are 8 Mechanical Engineering, 4 Civil Engineering, 1 Electrical Engineering, and 1 Business. The business major felt unconfident due to the fact that he or she had not yet taken any business courses, but knew that engineering was not a good fit. One ME student wished he or she had chosen a project that focused on disciplines other than ME just to be sure. One ME student wanted a better CAD lab and one ME student wanted more labs in the course. The others did not suggest course improvements.

There were four students who stayed at not confident at the beginning of the semester to the end of the semester. Of these four, 1 was Electrical Engineering, 1 Computer Science, 1 Civil Engineering, and 1 Undecided. The CS student suggested different labs and less group work in labs: “I liked that the class had labs that were designed to expose us to different types of engineering. However, I do not think that these labs did a good job of exposing us to different types. The labs were really only able to be done by one person, so it was hard for everyone to get equal exposure. The labs were also very short.” The CE student suggested having more labs.

6. Discussion

Here, we return to the research questions addressed in this study.
R1) Which activities do students find most helpful to choose their major?

Students in fall 2012 found the presentations about the professions and their own research about the professions the most helpful in terms of resources. They also found talking to people, especially family and friends, helpful in making their major choice. In fall 2015 students found most of the course elements to some degree helpful in choosing their major. One change is that the faculty member in his/her advising role became more helpful to students than in fall 2012. The course project also became more valuable in terms of helping students select a major. Overall, the resources that were deemed most helpful had the common theme of concern for the individual student: open-ended projects where they had a chance to explore and advice received through advising. The labs were the next most helpful; these allowed students to do hands-on work in each of the four disciplines. The next level down were resources that were more informational: student panel, student research paper, the course website of resources, and the club meeting attendance.

R2) Are students confident about their choice?

We answered this question in two ways. In fall 2012 we asked students about their view of their future career. In fall 2015 we asked them to rate their confidence level. The fall 2015 data shows that 94.2% of students were somewhat or very confident about their major choice at the end of the semester. Asked in a different question "I am confident about my major", 122 of 154 (79.2%) agreed or strongly agreed to this statement. Therefore, confidence level is likely between these values. In fall 2012, 84.3% of students agreed or strongly agreed that they were confident in succeeding in engineering or computer science.

R3) After the course, do students have an understanding of the branches of engineering and what engineers do?

In fall 2015 we explicitly asked students if their understanding of the branches of engineering improved and 73.4% responded agree or strongly agree. This suggests that most students do have an understanding of the branches by the end of the semester. In fall 2012 we asked students to respond to statements regarding the types of jobs engineers and computer scientists do and also what engineering/CS projects entail. Almost all students responded that engineering/CS projects involve creativity/innovation, teamwork, and math/science.

Connection to the Literature

The collection of activities offered in EGR 110 were designed to help students choose a major. As it relates to SCCT, one construct is *self-efficacy*. The course project and discipline-specific labs relate most closely to self-efficacy. We want to provide experiences for students to design and build a product, so they can gain confidence in their abilities to perform a task. The activities most closely linked with *outcome expectations* are the presentations about the professions, alumni videos, student panels, and student videos/blogs. With these resources, first-year students can start imagining the consequences of majoring in computer science or engineering. The student research project served to help students better understand their interests and connections to the disciplines. Finally, the *goals* construct was most closely aligned with the academic advising meeting and student panel. The faculty advisor asked about students' goals in individual meetings and the student panelists answered questions about their goals as students and professionals. A holistic approach of providing resources to students is helpful. Just as students respond to different teaching styles in different ways, students respond to advising and professional development resources in different ways. A suite of resources provides multiple pathways to access information.

Rodriguez-Simmonds and colleagues studied what information sources first-year students used to decide their major[21]. The results presented in this paper are consistent with their findings. They analyzed survey data in which students were asked to rank the resources that were important in helping them decide their major. Self-led exploration of the engineering disciplines was the top occurrence, followed by advice from people not at Purdue, advice from other Purdue students, and several others. Interviews with students confirmed the survey results. Students' own research and initiative to talk to others helped them identify which pathway to take. In a separate survey, students answered the question "Did activities help you decide which professional school to enter? Explain." Course presentations were, by far, listed most often. This is similar to the results of the study presented in this paper.

Continuous Refinement

There are numerous ways to support students in reflecting upon their interests and goals. Students were given the opportunity to provide feedback about the course in the survey. Each group was asked about other resources they thought would be helpful in selecting their major. Suggestions included having field trips to companies, bringing in guest speakers from industry (note that we do this in the context of club meetings and the videos, so students may not have utilized these resources effectively), more labs, a senior design fair (which we started in fall 2016), sitting in on advanced courses, talking more about the pathways within each field of engineering and different job titles, a professor panel in addition to a student panel, and more alumni videos. Logistically, field trips with 200+ first-year students has been a challenge to coordinate, so we have brought engineers to campus to discuss their work. The student clubs often organize plant tours and industry visits; we may need to do a better job encouraging EGR 100 students to take advantage of these opportunities.

We continue to explore methods and activities to help students identify their major choice. In fall 2016 we updated the course project to be multidisciplinary – design an urban, rural, or on-water wind turbine. The project included structural design, circuit design, programming, and mechanical design. The student research paper was moved from mid-semester to the first two weeks of the semester to get them exploring the branches of engineering earlier in the semester and to reduce the number of items due at the midterm.

7. Conclusion

Choosing a major can be a daunting task for students. The goal of this project was to identify resources that students find most helpful in choosing their major, so we can prioritize the elements to keep and update in the introduction to engineering course. According to student surveys, we have been successful in providing a suite of resources to help students choose a branch of engineering or computer science.

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